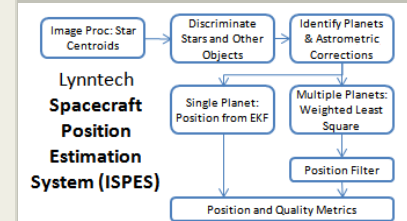# Spacecraft Position Estimation in Interplanetary Trajectories Using Star Trackers, Phase I

Completed Technology Project (2017 - 2017)

Project Introduction

Lynntech proposes a novel spacecraft position estimation method that leverages existing star trackers on board of a vehicle in an interplanetary trajectory for exploration missions. The method is based on observing visible planets in the solar system with Star Trackers and being able to discriminate between planets and fixed stars. Thus the proposed method is autonomous and does not require assistance from ground facilities. Space vehicle autonomy is particularly important to enable long term human exploration of space. Star Trackers are ubiquitous in space vehicles, having the function of estimating the vehicle attitude with respect to the inertial reference frame. This is accomplished by observing the fixed stars and comparing them with the on-board star catalog. Planets may also be observed, but the Star Tracker typically ignores such observations. It is possible to discriminate between stars and other bright objects in the image, thus the direction of observed planets in the camera reference frame can be evaluated, and the planet identified combining a number of heuristics, including time. The proposed method is based on a closed-form least-squares solution obtained by minimizing the sum of the expected object-space squared distance errors. A weighted least-squares solution is provided by an iterative procedure. The weights are evaluated using the distances to the planets estimated by the least-squares solution. Such novel weighted approach only requires one iteration to converge and results in significant accuracy gains compared to the simple least squares approach. The light-time correction is also taken into account. The proposed work includes the development of a library of algorithms to augment star tracker capabilities by providing the interplanetary position estimation function. This can be used in new Star Tracker development or to augment existing capabilities, at no additional requirement of weight or size for the spacecraft.

Spacecraft Position Estimation in Interplanetary Trajectories Using Star Trackers, Phase I Briefing Chart Image
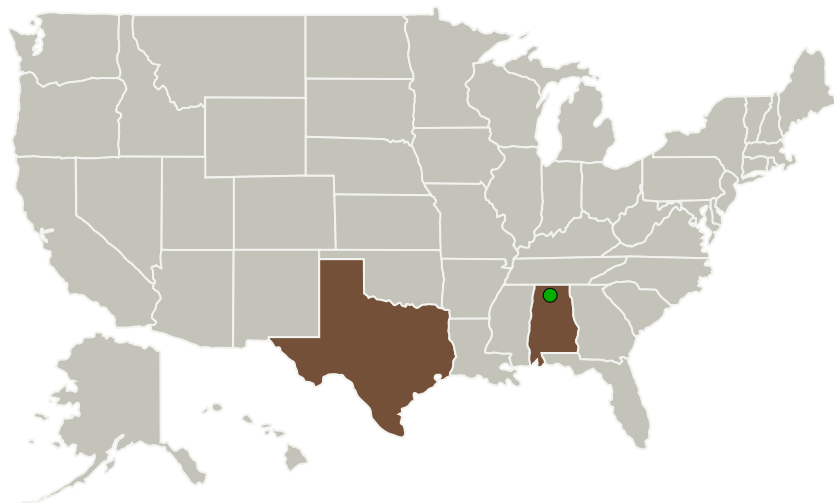
Table of Contents

Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
Lynntech, Inc.	Lead Organization	Industry	College Station, Texas
🟢 Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Lynntech, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

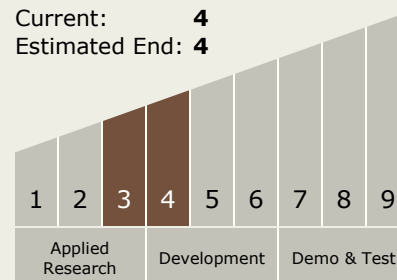**Program Director:**

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Christian Bruccoleri

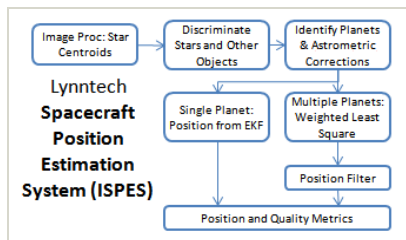## Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

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Images

Briefing Chart Image
Spacecraft Position Estimation in Interplanetary Trajectories Using Star Trackers, Phase I Briefing Chart Image
(https://techport.nasa.gov/image/132134)

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  └ TX17.2 Navigation Technologies
    └ TX17.2.3 Navigation Sensors

Target Destinations
The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System